Reforming case-based learning with non-linear gameplay: the potential of branched narratives and virtual patient models

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INTRODUCTION

Case-Based Learning (CBL) has become a major component of medical curricula and is featured prominently at the University of Ottawa. In this article, CBL is defined as a pedagogical method that uses fictional cases to reinforce important clinical skills [1]. Cases are organized into written sections pertaining to the patient's chief complaint, a history and physical examination, laboratory and diagnostic investigations, as well as management and follow-up plans [1]. These cases are delivered through self-directed online teaching modules or through group-oriented discussions. With either method, learners are expected to identify salient points from a given section, in order to anticipate the next steps in the management plan [1]. For example, if the history section describes a patient suffering from epigastric pain, students are encouraged to identify potential pain sources and use this knowledge to recognize the components that should be included in their approach to the physical examination. The ability to synthesize information to direct decision-making is a necessary competency of medicine supported by CBL [1-2].

A shortcoming of CBL is that the cases too often encourage a linear thought process [2]. Although students may discuss what they expect to find in a given section before clicking on the section's link, there is only one way to move from start to finish in each case [2]. This approach is not comparable to the one used in medical settings: physicians come to branch points where they must make decisions surrounding investigative methods and treatment protocols. These choices and the omission of others produce a set of information that influences decisions to come [2]. This point is made with an acknowledgement that there are many ways to deliver excellent care: two doctors may take different approaches to achieve great outcomes [2]. Nevertheless, it is important to recognize that certain decisions can have far-reaching consequences and that traditional CBL may inadequately address the multidirectional aspect of medical care. Despite this limitation, group discussions and online learning modules tailored around CBL should not be abandoned. Instead, efforts should be directed towards improving CBL to give students a better opportunity to explore the consequences of medical decisions.

In order to promote decision making, linear cases can be restructured using branched narratives. Under this model, authors would first create the "critical pathway," which Conradi et al. (2007) describe as "the sequence of events that define an ideal storyline where the learner makes [the best] decisions from beginning to end" (Figure 1) [3]. Once this critical pathway is established, authors can then add branch points to create alternative pathways (Figure 1) [4]. Decisions at these points would impact the direction of the narrative and the outcome of the patient (Figure 1) [4]. These points can be added to reflect real events experienced by on-staff clinicians, or they can be organized around points of tension and misunderstanding identified from past test results [4]. The pathways and their endpoints can be planned using the Visual Understanding Environment (VUE) software, a free public tool created by Tufts University [4]. By using tools such as VUE, authors can devise a visual representation of the case before transferring it to web-based applications (Figure 1). The end result is a branched narrative structured on the principle of decision making.

CBL, in the form of self-directed learning modules, can also be enriched with virtual patient (VP) cases. The VP model is best appreciated by examining the "Virtual Interactive Case" system designed by the University of Toronto [5]. Using this system, the learner is confronted with the VP's presenting complaint, and from this section they continue to the history component where they select the questions they feel are relevant to the case [5]. These questions cost time and money, and are added to the user's total money and time scores [5]. When a question is selected, the user is provided with the virtual patient's answer [5]. This framework is similarly applied as the user progresses through the complete patient work-up (e.g. physical examination, imaging) [5]. At any time, the user has the ability to go back to a previous section to acquire more information, making the cases exploratory rather than branching [5]. The user, once they are satisfied with their investigations, is then able to select a diagnosis from a list of differentials, while choosing an accompanying management plan [5]. A cornerstone of VPs is the availability of feedback [4]. At the end of the "Virtual Interactive Case" experience, the user is forwarded to a debriefing summary that lists the essential actions performed, the essential actions missed and the irrelevant actions completed [5]. The summary lists the estimated time and cost of the case, with each component compared to recommended values and broken down into the decisions made [5]. Although the recommended values are somewhat arbitrary, these gameplay elements encourage users to think about time and cost, variables that are underemphasized in linear CBL. The most powerful tool for feedback is often the patient's state of health, which is dependent on the learner's medical decisions

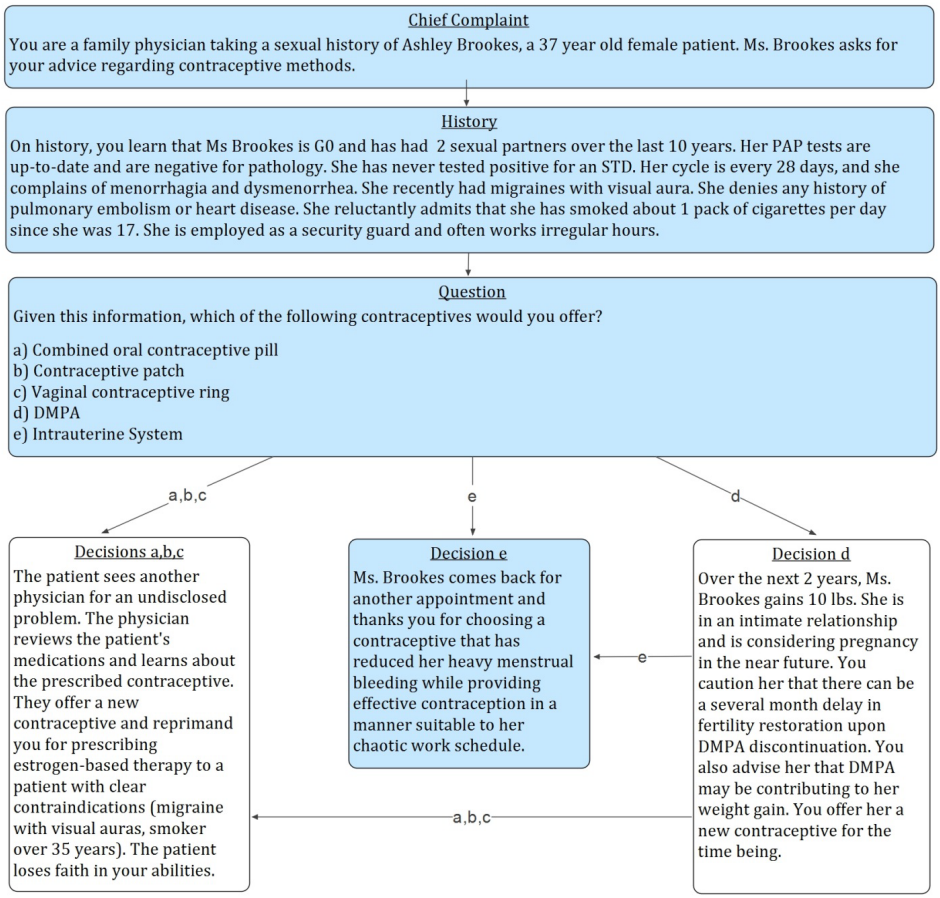

Figure 1. Contraceptive Care: An Example of a Branched Narrative. This case is formatted with a branched storyline. The user, based on the provided history, is required to make a decision regarding the appropriateness of five contraceptive methods. Decision "e" results in the best outcome for the patient in the shortest time, and hence it represents the critical pathway (labelled in blue). Decision "d" is an acceptable alternative, but it results in unexpected information that forces the user to select another contraceptive method. The "d to e" pathway highlights the ability of branched narratives to show the slightly different routes that clinicians may take to reach similar favorable outcomes. Decisions "a,b,c" result in an undesirable outcome for both the patient and the family physician, allowing the user to experience the ramifications of poor decision making in a safe environment. The outcomes of every decision were linked with explicit educational information (e.g. "there can be a several month delay in fertility restoration upon DMPA discontinuation) to bolster the teaching value of the case. Although it was not included in this example, the case could be created so that each outcome is linked with a numerical score, with the best outcomes producing the best score. Gameplastatistics would allow competition between CBL groups in order to encourage debate and participation. This storyline was not based on any real case, and was created using VUE to show the ability of branched narratives to teach the indications and contraindications surrounding medical treatment. The case was created using contraceptive information found in Williams Gynecology, 2nd 223 edition (13).

[4]. VP cases, although slightly different from branched narratives, are structured to offer equally stimulating environments predicated on decision making and feedback.

An evaluation of the merits of non-linear CBL

In order to determine whether branched narratives and VP models are appropriate learning tools worth adopting, one must evaluate these methods based on the following factors: student attitudes, economic feasibility, and clinical skill development

If a program is to be adopted it must be endorsed by the student population. There are several studies that examine student attitudes towards these teaching models. At St. George's University of London (SGUL), educators created VP cases to teach the ethical competencies of medicine [6]. Of the 601 students who completed the online cases, 85% believed that this educational tool was effective at improving their confidence with medical ethics and professionalism [6]. The same school experimented by replacing group-oriented linear cases with prototypes of a branched nature [2]. Upon review, 70% of students responded that group discussions were more engaging when a branched narrative was offered, since the decision points provided a better opportunity for debate [2]. This experience has not been common to all studies. Students from the University of Pittsburgh School of Pharmacy (UPSP) preferred traditional styled lectures as opposed to self-learning modules designed with branched narratives [7]. These findings may reflect the notion that users are uncomfortable with active learning environments, since students have been indoctrinated with passive lecture-based teaching methods since primary school [7]. Despite their preference, these students found the branched learning modules to be challenging, organized and helpful in fostering their understanding of course content [7]. In general, students seem to react positively to cases delivered through branched story-telling and VP cases.

Secondly, a program must be delivered in a cost – and time – effective manner to be adopted by the administrative staff. The production of branched narratives at SGUL took about 10 hours per case [2]. At UPSP, directors commented that the largest obstacle to program development was that of design and production: it required 50 hours to create the initial webbased VP template [7]. The authors did note, however, that once the initial template was produced, the extra time needed to design the cases was quite reasonable [7]. Huang et al. (2007) noted that there were extensive time and budgetary restrictions sur-

rounding VP case development [8]. Of the 108 U.S and Canadian medical schools that responded to their survey, only 26 had incorporated VPs into their curricula. This may reflect the fact that each case took on average 16.6 months to create, with 84% of the cases requiring more than 10000 dollars to develop [8]. This study was conducted in 2005 and the substantial investment of time and money may reflect the lack of open resource technology available at that time

Although these investments may seem unjustifiable, there are several proven strategies that can be used to mitigate costs. The production demands imposed by the transition from linear to branched narratives can be lessened by re-using the linear cases as critical pathways [2]. The rate-limiting step in VP case development is often template production [7]. Through due diligence, these costs can be minimized by using open resource platforms like OpenLabyrinth, as they offer user-friendly VP templates [4]. It is recommended that schools share cases using open resource databases or develop collective cases through strengthened institutional collaboration [4]. This cost reduction strategy is starting to take hold across the country. In fact, the Pathways for Interactive Narrative Education (PINE) project was developed in partnership between the Northern Ontario School of Medicine and other health professional schools found within Ontario [9]. This collaborative venture has generated 60 virtual patient cases that are available for general public access at http://pine.nosm.ca/pine/ [9]. Endeavors such as the PINE project are very promising and demonstrate that branched narrative and VP case development can be delivered in volume with reasonable cost and time projections.

The decision to implement non-linear CBL ultimately depends on the ability of branched narratives and VP models to effectively train students in the core competencies of medicine. Unfortunately, there is little data objectively comparing the effectiveness of these teaching models with other learning styles, with respect to knowledge retention and patient outcome. One study found that there was no significant difference in examination results between those students who were taught through traditional lectures and those assigned to branched cases [10]. Comparisons such as these may be flawed since examination methods at the undergraduate level often focus on information recall, rather than on the high order skills emphasized in branched narratives and VP cases [10]. Despite the lack of data comparing teaching methods, branched narratives and VP cases are likely an ideal instructional modality for clinical reasoning. This skill is defined by Cook and Triola (2009) as the "application of knowledge to collect and integrate information from various sources to arrive at a diagnosis and management plan" [11]. Experts believe that clinical reasoning is best promoted by teaching methods that make learners commit to their decisions, in a nature that probes their reasoning and offers feedback as to what they did well and what they did poorly [12]. As compared to linear CBL, learners using branched narratives and VP cases must be more committed to their decisions, as they live out the consequences of actions taken. By experiencing the repercussions of their decisions, users receive more effective feedback via the outcome of their patient. Using this paradigm, branched narratives and VP cases would appear to be superior instructional modalities for promoting clinical reasoning, as compared to linear CBL. More research is needed, however, to determine whether this paradigm holds true in practice.

What role should these models play in medical training?

It is important to consider the role that branched narratives and VP cases should play in pre-clerkship medical curricula. Although a theoretical argument can be made that these methods are better training modalities for clinical reasoning than linear CBL, more research is needed to evaluate these methods based on endpoints of knowledge retention and healthcare delivery. At this point, pilot programs focused on branched narratives and VP cases should be initiated since these methods appeal to the desires of students and can be feasibly delivered using options that help reduce the costs to administration [2, 6, 7, 9]. Despite the potential benefits of these teaching models, we must recognize that they are not a replacement for all other teaching styles. Standardized patients are likely a more effective modality for strengthening communication skills, since it is difficult to practice empathy in the artificial environment of virtual cases [10-11]. Lectures are better adapted for providing core knowledge, whereas human patient simulators are a superior tool for promoting procedural skills [11]. If pilot programs are initiated, every effort should be made to ensure that branched narratives and virtual patient cases are integrated with lectures, simulators and standardized patients in pre-clerkship curricula, in order to develop the wide range of competencies required for real-life scenarios

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Keywords: case-based learning, CBL, branched narrative, virtual patient, VP, non-linear gameplay, branched story telling, non-linear CBL, interactive case, critical pathway, linear narrative